ISSN: 2581-8651
Vol-5, Issue-2, Mar-Apr 2023
https://dx.doi.org/10.22161/jhed.5.2.2
Peer-Reviewed Journal

Journal of Humanities and Education Development (JHED)

Correlation between Distribution of Water Fluoride and Fluorosis in the villages of Mahendergarh district, Haryana- India

Sucheta Yadav

Department of Geography, Pt. NRS Govt College, Rohtak-124001, Haryana-India.

Received: 17 Jan Dec 2023; Received in revised form: 22 Feb 2023; Accepted: 05 Mar 2023

Abstract

Fluoride plays a very important role in preventing dental carries and is beneficial for dental enamel. But fluoride is valuable for health only when if it is used in a small amount within the allowable limit. Its excessiveness causes a number of side effects for human health such as fluorosis. According to WHO recommendation in 2011, fluoride level in drinking water is 1.5 mg/l. In everyday life, drinking water is considered as major source of fluoride. Most of the residents of Mahendergarh district of Haryana in India depend on ground water for their drinking purposes. This study has been conducted to examine the dental fluorosis among govt. school children in the villages of the study area. The fluorosis data were collected from different blocks of Mahendergarh district from school going children aged between 6 to 11 years old. A face-to-face interview of school children from class-3rd to class-5th has been carried out. A total of 43 villages were selected for dental fluorosis analysis. 25 villages were selected where the fluoride level is more than 1.5 mg/l and 18 villages were chosen where fluoride level was less than 1.5 mg/l. A survey was carried out among 1196 school going children for oral examination of dental fluorosis. School children were examined with the help of an expert of dental fluorosis. The study revealed that children of Sihma, Mahendergarh, Narnaul and Nangal Chaudhary blocks are the most affected with dental fluorosis. It was found that 33.3% children were affected with dental fluorosis in high fluoride zone, while only 7.36% children were suffering from dental fluorosis below permissible area (below 1.5mg/l). The study also reveals the positive correlation between water fluoride and fluorosis.

***Keywords*— Fluoride, Dental fluorosis, Drinking water, Correlation**

I. INTRODUCTION

Water is one of the most precious and immeasurable resource of environment that is potentially useful for human being. It usually makes up 55 percent to 78 percent of the body. Roughly 71 percent surface of the earth is covered by water; despite it only freshwater that is only 3 percent (mostly available as a glacier) of total available water is suitable for living organisms (Kurunthachalam, 2014). Groundwater is the major source of water for supporting human existence on the earth. But unfortunately, from last few decades, these components of environment are deteriorating very fast due to some natural and anthropogenic processes. After discovery of fire and wheel, man entered into industrial stage but environment is becoming more contaminated by the various pollutants due to industrial revolution. The European Economic Community (EEC) has placed the various pollutants into two list –Black list and Grey list according their dangerousness. The study is mainly associated with one specific pollution, namely fluoride pollution that occurs in grey list of EEC at no.07 along with cyanides and less toxic than arsenic contaminant (Agarwal, 2001).

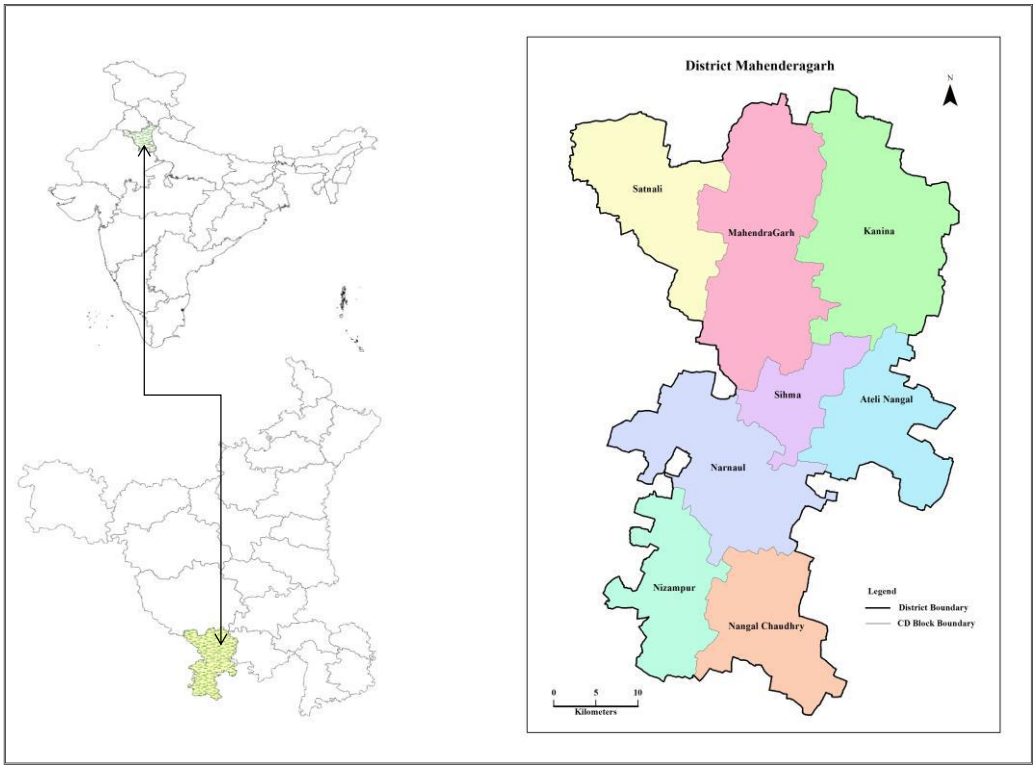
All over the world, 200 million people are consuming such water that is contaminated with high fluoride (Ayoob & Gupta, 2006). Fluoride is non biodegradable element that is the most phototoxic among contaminants. It accumulates in plants as well as in soil and water both from low to high concentration (Fornasiero, 2001). In the earth lithosphere fluoride is the 13th most abundant element (Gikunju et.al; 1992). Approximate 0.06 - 0.09 percent portion of the crust is represented by fluoride (Wedepohl, 1974). Fluoride is a calcium seeking element and approximately 96 percent of fluoride is mainly found in teeth and bones in the human body. Fluoride is a vital oligo – element and it plays a very important role in preventing dental carries and is beneficial for dental enamel. It is a key fundamental factor that develops the bones (McDonagh et. al; 2000; Boulétreau et. al; 2006; Messaïtfa, 2008). But

there is a specific condition in the utilization of fluoride, that fluoride is valuable for health only when if it is used in a small amount within the allowable limit. Its excessiveness causes a number of side effects for human health such as fluorosis especially dental fluorosis is very common. In everyday life, drinking water is considered as major source of fluoride. Consumption of water by a person depends upon many factors in which climate is the most essential factor. As the world's population is distributed in various climatic zones, so many organizations have taken the ideal fluoride level in drinking water. According to WHO recommendation in 2011, fluoride level in drinking water is 1.5 mg/l. India has naturally high fluoride concentration zones, as a result of this in India, 1 mg/l fluoride level is recommended as national standard and according Bureau of Indian Standard, it is 0.6 mg/l to 1.2 mg/l.There are numerous sources of fluoride but the major source is intake of drinking water (Kumari and Rao 1993). In minute quantity, fluoride has beneficial effect on human health. Fluorosis is a disease in human being that is due to long intake of excessive amounts of fluoride. Main characteristics of fluorosis are mottling of teeth and soft and crumby bones. Fluorosis can be classified mainly into two types-dental fluorosis and skeletal fluorosis.

Fluorosis is a major health issue across the world, especially in developing countries like India. It has become a flaming problem of the 21th century. More than 200 million people drink water exceeding the WHO limit i.e. 1.5 mg/l. These includes about 66 million people in India (Majumdar, 2011), 45million people in China (Wuyi et. al; 2002) & about 5 million people in Mexico (Díaz-Barriga et. al; 1997). Seventeen states have been identified as endemic for fluorosis in India and Haryana is one of these states. All over the world about 25 countries are facing the problem of endemic fluorosis. About 65 percent of endemic fluorosis across the world is mainly due to fluoride pollution of drinking water (Felsenfeld & Roberts, 1991; WHO, 2002). The occurrence of fluorosis in all over the world was noted to be about 32 percent (Mella et al; 1994). In India, approximately 177 districts have been identified as fluoride affected areas. Studies on correlation between water fluoride and fluorosis carried out by many researchers in all over the world. Grimaldo et. al; (1995) examined 11-13 years old children in San Luis Potosi, Mexico to find out endemic fluorosis. It was found that where the fluoride concentration was below 0.07 ppm, the prevalence of dental flourosis was 68%, whereas at fluoride concentration level higher than 2ppm, prevalence of dental fluoride among children was 98%. Samal & Naik (1988) conducted a survey among school children in the vicinity of aluminum factory in India and found that there was a strong correlation between dental flourosis in school going children and fluoride level in drinking water. Chand (1999) conducted the study of fluoride in relation to human health. He found that excess of fluoride caused many health problems in mankind Bardsen et. al; (1999) carried out a survey related to prevalence of dental fluorosis among persons in western Norway, Europe and found that the percentage of severity of fluorosis among the persons who were consuming low fluoride drinking water was 14.3% and among the persons who were consuming moderate to high fluoride drinking water was 78.8%. Choubisa et. al; (2001) conducted a study in 10 villages of Dungarpur district of Rajasthan where concentration of fluoride in drinking water varied from 1.22 ppm to 8.9 ppm. 70.6% children below 18 years at 1.7 mean fluoride concentration and 100% children at 6.1 mean fluoride concentration were found to be affected with dental fluorosis, 68% adults at 1.7 mean fluoride concentration and 100% adults at 6.1 means concentration were found to be affected with dental fluorosis. Kotecha et. al; (2012) evaluated 6093 permanent residents of 11 villages of Vadodara district, Gujarat to find out the dental fluorosis. It was found that 59.31% inhabitants were affected with dental fluorosis and 39.53% affected with dental caries in high fluoride area and 39.21% residents were affected with dental fluorosis and 48.21% affected with dental caries in normal fluoride area respectively. Some studies have been also carried out to find out correlation between water fluoride and fluorosis in Haryana (Meenakshi et al, 2004; Yadav & Lata, 2002; Yadav et al, 2009)

Study Area:

Mahendergarh district is situated in the south west of Haryana state, India. It is located between 75^0 56' to 76^0 51' East longitudes and 27^0 47' to 28^0 26' North latitude (Map-2.1). It consists of 370 villages and eight blocks namely Nangal Chaudhary, Ateli, Mahendergarh, Kanina and Narnaul, Nizampur, Satnali and Sihma. Mahendergarh district is located in very hot tropical and sub tropical climatic zone and gets less rainfall throughout the year. During the last decade (2004-2014), water table declined in all the blocks of the district. Fluoride bearing mineral rocks is found in the area. Mahendergarh district is the 4th least populous district of Haryana. According to census 2011, the population of the district is 922,088.



II. METHODOLOGY

Water samples from different drinking water sources were collected from villages/sites of Mahendergarh district to determine the level of fluoride during Dec. 2016 to February 2017. Geographic locations of sampling sites were mapped by using Global Positioning System (GPS). Ion Selective Electrode (ISE) Method was used to calculate the fluoride content in drinking water.The fluorosis data was collected from eight blocks of Mahendergarh district from school going children aged between 6 - 11 years old. A total of 43 villages were selected for dental fluorosis analysis. 25 villages were selected where the fluoride level was more than 1.5 mg/l and 18 villages were chosen where fluoride level was less than 1.5 mg/l. A survey was carried out among 1196 school going children for oral examination of dental fluorosis.

III. RESULTS

Ground water fluoride concentration in different villages varied in different blocks of district Mahendergarh. Further,villages were divided into two categories-less than 1.5mg/l and above 1.5mg/l and fluorosis among 1196 school going children was observed and the results are tabulated below:

Table – 1.1 Distribution of Water fluoride and fluorosis in Low Fluoride Level Villages below 1.5 mg /l

Sr. no.	Villages	Fluoride concentration (mg/l)	N of individuals examined	No of affected individuals
1	Sohla	0.5	25	2(8%)
2	Satnali	0.9	40	Nil
3	Balana	1.1	50	2(12.5%)
4	Dongra Ahir	1.1	17	2(11.7%)
5	Dongra jat	1.0	20	2(10%)
6	Kalwari	1.4	16	Nil
7	Sareli	1.1	12	4(33.3%)
8	Bamnawas	1.3	15	2
9	Golwa	0.8	18	1

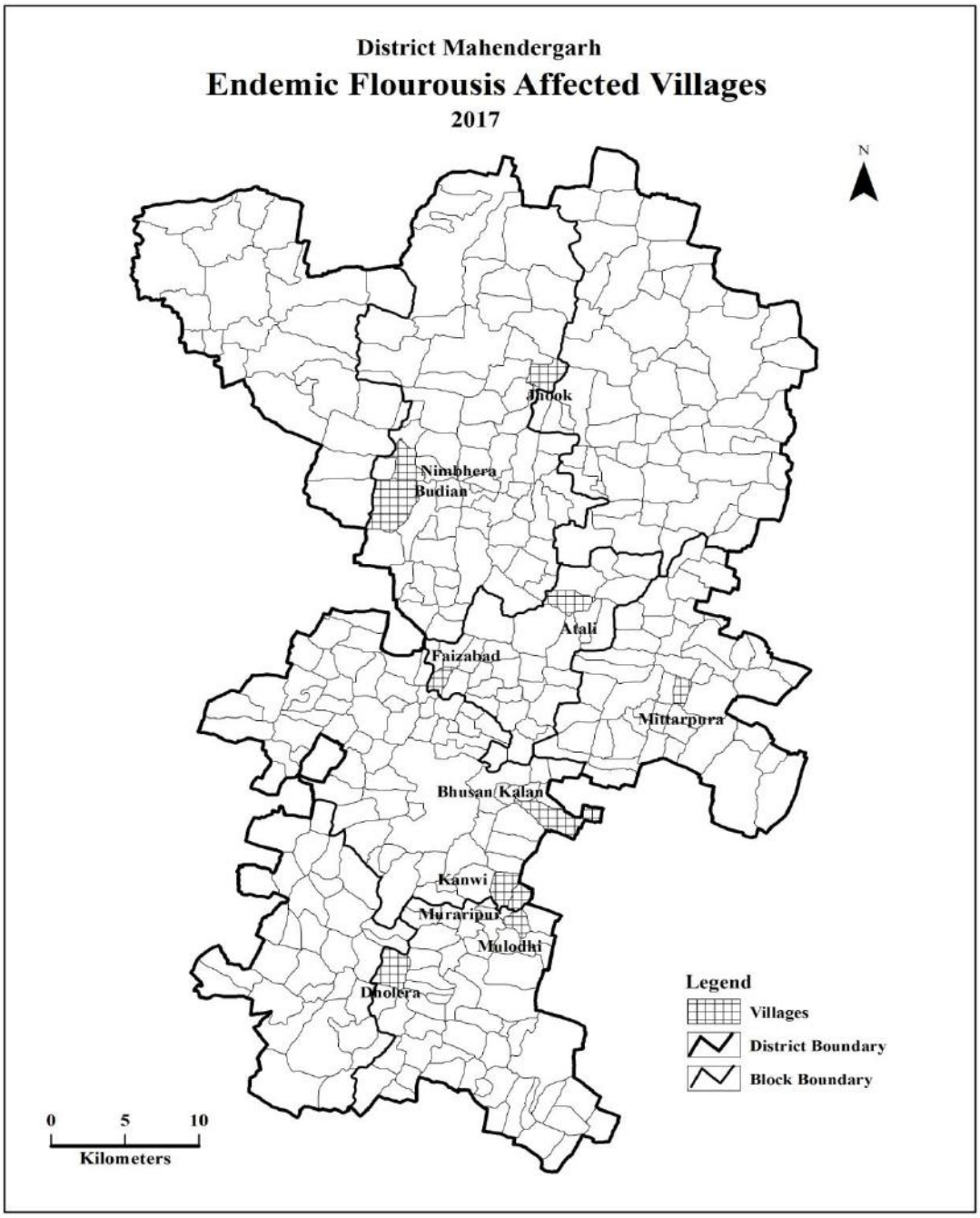
10	Chandpura	0.6	25	Nil
11	Rampura	0.8	32	Nil
12	Kanti	1.2	70	9(12.8%)
13	Aghihar	1.2	40	3(7.5%)
14	Bhagot	0.6	46	9(19.5%)
15	Gudha	0.4	50	Nil
16	Rewasa	1.1	25	Nil
17	Jat pali	0.6	38	4(10.5%)
18	Paiga	1.1	18	1(5.5%)

Table – 1.2 Distribution of Water fluoride and fluorosis in high Fluoride Level Villages above1.5 mg /l.

Sr. no.	Village	Fluoride concentration (mg/l)	No of individuals examined	No of affected individuals
1	Kanwi	5.8	22	15(68%)
2	Muraripur	6.9	10	5(50%)
3	Hamidpur	2.1	45	9(20%)
4	Badopur	1.7	35	6(17%)
5	Bhushan kalan	2.6	14	7(50%)
6	Atali	4.9	12	8(66.6%)
7	Faizabad	6.0	15	11(73.3%)
8	Mittarpura	5.8	30	16(53.3%)
9	Surana	3.1	20	4(20%)
10	Duloth Jat	2.2	13	4(30.7%)
11	Akoli	1.8	9	2(22.2%)
12	Dholera	2.3	20	10(50%)
13	Kamania	3.2	46	2(4.3%)
14	Meghot	2.3	19	4 (17.3)
15	Mulodhi	7.0	58	30(51.72%)
16	Notana	2.4	10	5(50%)
17	Pathera	2.5	70	12(17.4%)
18	Saina	2.2	35	5(14.2%)
19	Unchat	2.3	16	5(31.2%)
20	Chitroli	2.1	20	6(30%)
21	Basai	1.6	44	12(27.2%)
22	Bhagdana	2.2	20	05(25%)
23	Budian	1.7	22	11(50%)
24	Jhook	3.7	10	5(50%)
25	Nimbhera	4.2	24	13(54.16%)

Table 1.1 and 1.2 show that villages Kanwi, Muraripur, Bhushan Kalan, Atali, Fazibad, Mittarpura, Dholera, Mulodhi, Notana, Budian, Jhook and Nimbhera where the water fluoride is very high, fall under the endemic fluorosis range where the fluorosis was found from 50% to 70%

Map-1.2



Correlation between Water Fluoride and Fluorosis

Correlation was observed between level of water fluoride and affected individuals with fluorosis in the villages of different blocks of district Mahendergarh

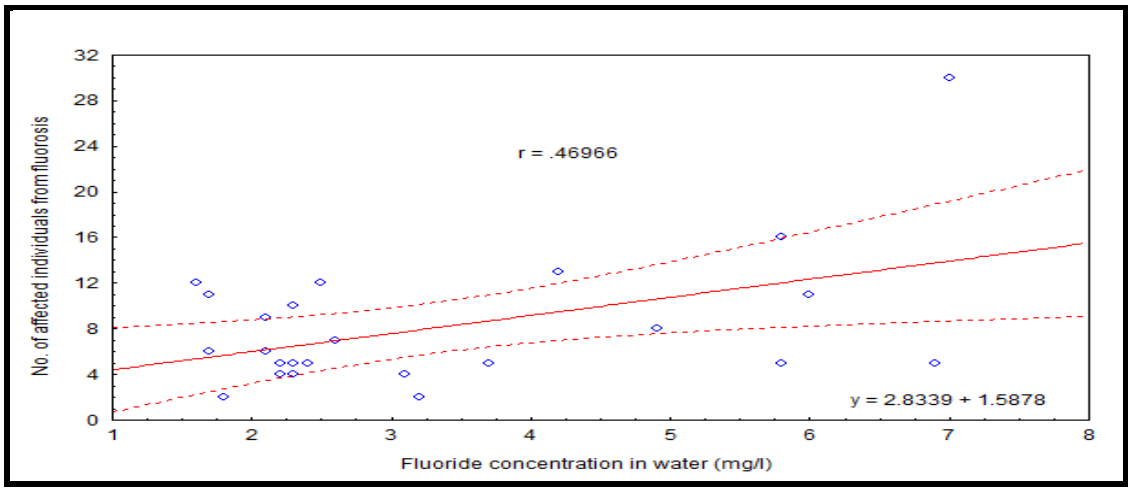


Figure -1.1 Correlations between fluoride content in water and No. of affected individuals with fluorosis (level of fluoride in water > 1.5 mg/l)

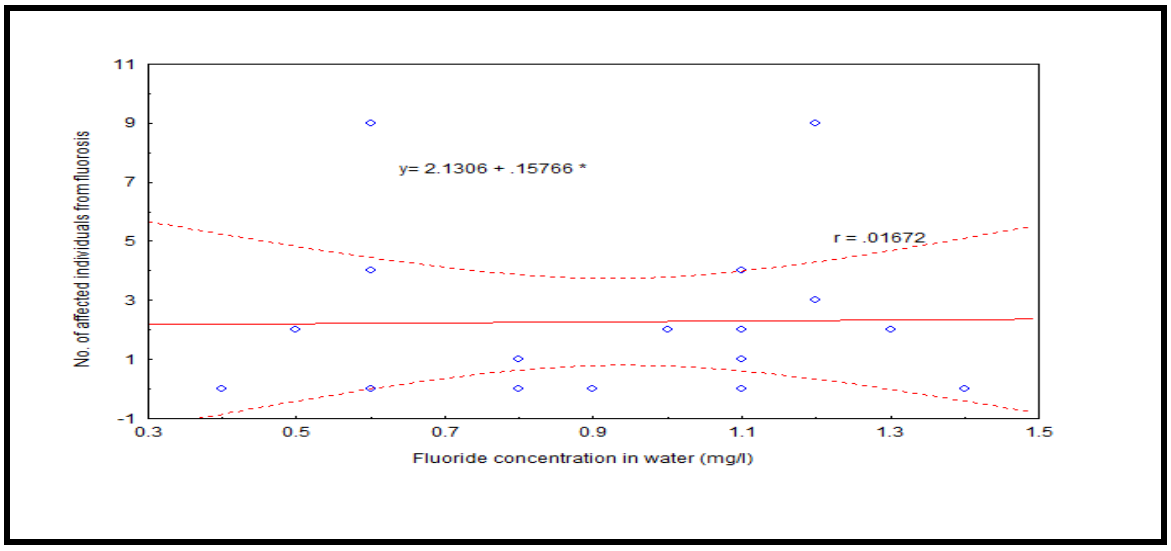


Fig.1.2 Correlation between fluoride content in water and No. of affected individuals suffer from fluorosis (level of fluoride in water < 1.5 mg/l)

The observed data indicates as the increases of fluoride content in water the increasement of fluorosis disease was observed in the villages of Mahendergarh district. We were analyzed the data of 43 villages in two categories, the 18 villages characterized as lower content of fluoride level (<1.5mg/l) and 25 villages characterized as higher content of fluoride level (>1.5mg/l). Figure 1.1 represents a positive correlation (r=0.4696) between 25 villages having with higher content of fluoride level (>1.5mg/l) and no. of affected individuals suffer from fluorosis diseases of Mahendergarh district of Haryana. On the other hand, very poor positive correlation (r=0.01672) between 17 villages having with lower content of fluoride level (<1.5mg/l) and no. of affected individuals suffer from fluorosis diseases of Mahendergarh district of Haryana (figure 1.2). A Comparative analysis of villages with higher content of fluoride level and lower higher content of fluoride level and No. of affected individuals suffer from fluorosis of Mahendergarh district in Haryana (figure 1.3)

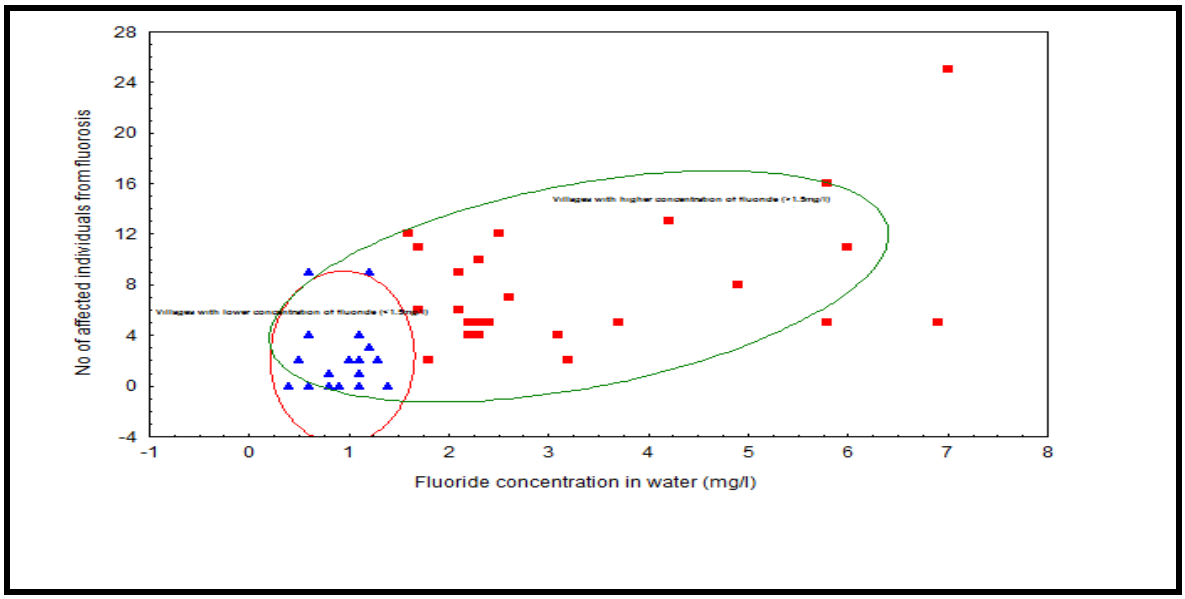


Fig.1.3 Comparison of villages with higher and lower fluoride content in water and No. of affected individuals suffer from fluorosis of Mahendergargh district.

IV. DISCUSSION

In this study, it was observed that 33.33% children among 639 were affected with dental fluorosis while remaining 66.67% were normal in a rich fluoride area, while only 7.36% of 557 children were abnormal and suffered from dental fluorosis and remaining 92.6% of children normal in the normal fluoride zone and had not sign of decline. Eating habits of the population of any region is directly affected by the climate of that region. Intake amount of drinking water by individuals are completely dependent on the atmospheric temperature. According to WHO 2006, fluoride concentration greater than 1.5 mg / l of water can cause fluorosis. As recommended by the WHO in 2002, in hot climates, consumption of drinking water is more so the optional fluoride level can be less than 1.0 mg /l. In cold climates, low water consumption than those living in warmer climates, so in a colder environment, favorable fluoride levels can reach 1.2 mg / l. Fluorisis will also work in this area if the fluoride concentration in the drinking water is less than 1.5 mg / l, as residents are exposed to high concentrations of fluoride in the air, food or nutritional products (Cao et al. 1992). According to the National Research Council (NRC, 2001), a daily and adequate amount of fluoride intake for infant age < 6 month age is 0.1-0.5 mg / person / day; 0.2-1.0 mg / person / day for infant between 6-12 months age; 0.5-1.0 mg / person / day for children 1 to 3 years of age, 1.0 to 2.5 mg / day / day for children from 7 years for adults and 1.5 to 4.0 mg / person / day for adults.

In district Mahendergarh, during the summer season, extremely hot conditions are present and the temperature fluctuates from 25° to 48° C. In extreme climatic conditions, the optimum level of fluoride in drinking water should be between 0.5 and 0.7 mg/l according to the World Health Organization (Murray, 1986). Although the data presented in this study show a direct relationship between fluorosis and fluoride water, these results confirm that other studies and proved that high fluoride concentrations increase the prevalence of fluorosis (Yadav et al., 2008, Bhalla et al., 2015, Ramesh et al., 2016 and Sunil et al., 2017). Gopalakrishnan et. al; (1991) conducted a survey among school going children and villagers in ten villages near Tuticorin of Chidambaran district of Tamil Nadu and highest percentage of fluorosis was found 21.67%. Dahiya et. al. (2000) carried out a study of 1014 individuals (634 male and 380 female) among school children in school of Juai Kala village of district Bhiwani. Out of total 916 children were found suffering with different types of dental fluorosis. Excessiveness of fluoride can be the cause of dental fluorosis (Susheela, 2001).

The study also found that fluoride also affects children in a low fluoridated area, as water consumption is highest in hot climates; although the percentage of children affected was very low i.e. 7.63%. But the occurrence of dental fluorosis can be very different in different villages with almost the same fluoride in drinking water. The results showed that the populations of some villages in the study area were chronically exposed to higher levels of fluoride in drinking water.

V. CONCLUSION

This study reveals that high fluoride level in water plays a vital role in the existence of fluorosis among school children in Mahendergarh district. The positive correlation between fluorosis and high fluoride level was noted in the area. Consumption of drinking water by the residents in the area is very high as this area lies in the dry zone. Permanent remedy for fluorosis cannot be possible, only prevention is a remedy. Changing the eating habits can decrease the degree of dental fluorosis. Residents of the area should control the eatables having high fluoride intake like black salt, black tea etc and should take adequate amount of vitamin C and calcium. The government should also imply the defluoridation schemes and fluorosis awareness programs for the residents of the area.

REFERENCES

[1] Agarwal, K. C. (2001). *Environmental Pollution: Causes, Effects & Controls*. Nidhi Publishers (India).

[2] Ayoob, S., & Gupta, A. K. (2006). Fluoride in drinking water: a review on the status and stress effects. *Critical Reviews in Environmental Science and Technology*, *36*(6), 433-487.

[3] Bardsen, A., Klock, K. S., & Bjorvatn, K. (1999). Dental fluorosis among persons exposed to high-and low-fluoride drinking water in western Norway. *Community Dentistry and Oral Epidemiology*, *27*(4), 259-267.

[4] Bhalla, A., Malik, S., & Sharma, S. (2015). Prevalence of dental fluorosis among school children residing in Kanpur City, Uttar Pradesh, India. *European Journal of General Dentistry*, *4*(2), 59.

[5] Boulétreau, P. H., Bost, M., Fontanges, E., Lauverjat, M., Gutknecht, C., Ecochard, R., & Chambrier, C. (2006). Fluoride exposure and bone status in patients with chronic intestinal failure who are receiving home parenteral nutrition. *The American Journal of Clinical Nutrition*, *83*(6), 1429-1437.

[6] Cao, S. R., & Li, Y. F. (1992). The evaluation of indoor air quality in areas of endemic fluorosis caused by coal combustion. In *Proceedings of the XIX Conference of the International Society for Fluoride Research, Kyoto, Japan*

[7] Chand, D. (1999). Fluoride and human health-Cause for concern. *Indian Journal of Environmental Protection*, *19*, 81-89.

[8] Choubisa, S. L. (1997). Fluoride distribution and fluorosis in some villages of Banswara district of Rajasthan. *Indian Journal of Environmental Health*, *39*(4), 281-288.

[9] Dahiya, S., Kaur, A., & Jain, N. (2000). Prevalence of fluorosis among school children in rural area, district Bhiwani: A case study. *Indian Journal of Environmental Health*, *42*(4), 192-195.

[10] Díaz-Barriga, F., Leyva, R., Quistián, J., Loyola-Rodríguez, J. P., Pozos, A., & Grimaldo, M. (1997). Endemic fluorosis in San Luis Potosí, México: IV. Sources of fluoride exposure. *Fluoride*, *30*(4), 219-222.

[11] Felsenfeld, A. J., & Roberts, M. A. (1991). A report of fluorosis in the United States secondary to drinking well water. *Jama*, *265*(4), 486-488

[12] Fornasiero, R. B. (2001). Phytotoxic effects of fluorides. *Plant Science*, *161*(5), 979-985.

[13] Gikunju, J. K., Githui, K., & Maitho, T. E. (1992). Fluoride levels in borehole water around Nairobi. *Fluoride*, *25*(3), 111-11

[14] Gopalakrishnan, S. B., Viswanathan, G., & Ilango, S. S. (2012). Prevalence of fluorosis and identification of fluoride endemic areas in Manur block of Tirunelveli district, Tamil Nadu, South India. *Applied Water Science*, *2*(4), 235-243.

[15] Grimaldo, M., Borjaaburto, V. H., Ramirez, A. L., Ponce, M., Rosas, M., & Diazbarriga, F. (1995). Endemic fluorosis in San-Luis-Potosi, Mexico. 1. Identification of risk-factors associated with human exposure to fluoride. *Environmental Research*, *68*(1), 25-30.

[16] Kabata-Pendias, Alina & Pendia, H. (1992). *Trace elements in soils and plants.* CRC Press, Boearaton, F. L.

[17] Kabata-Pendias, Alina & Pendia, H. (1992). *Trace elements in soils and plants.* CRC Press, Boearaton, F. L.

[18] Kotecha, P. V., Patel, S. V., Bhalani, K. D., Shah, D., Shah, V. S., & Mehta, K. G. (2012). Prevalence of dental fluorosis & dental caries in association with high levels of drinking water fluoride content in a district of Gujarat, India. *The Indian Journal of Medical Research*, *135*(6), 873-877.

[19] Kumari, S. D., & Rao, P.R. (1993). Endemic Fluorosis in the Madras Presidency (Indian) *Journal of Medical Research*, 25, 553-558.

[20] Kurunthachalam, S. K. (2014). Water conservation and sustainability: an utmost importance. Hydrology: Current Research, 5(2), 1-3.

[21] Majumdar, K. K. (2011). Health impact of supplying safe drinking water containing fluoride below permissible level on flourosis patients in a fluoride-endemic rural area of West Bengal. *Indian journal of Public Health*, *55*(4), 303.

[22] McDonagh, M. S., Whiting, P. F., Wilson, P. M., Sutton, A. J., Chestnutt, I., Cooper, J.,& Kleijnen, J. (2000). Systematic review of water fluoridation. *Bmj*, *321*(7265), 855-859.

[23] Meenakshi, Garg, V.K., Kavita, Renuka, & Malik, A., (2004). Groundwater quality in some villages of Haryana, India: focus on fluoride. *J Hazard Mater* 106: 85-97.

[24] Mella, S., Molina, X., & Atalah, E. (1994). Prevalence of endemic dental fluorosis and its relation with fluoride content of public drinking water. *Revista Medica De Chile*, *122*(11), 1263-1270.

[25] Murray, J. J. (1986). Appropriate use of fluorides for human health. *Geneva: World Health Organization.*

[26] Ramesh, M., Narasimhan, M., Krishnan, R., Chalakkal, P., Aruna, R. M., & Kuruvilah, S. (2016). The prevalence of dental fluorosis and its associated factors in Salem district. *Contemporary Clinical Dentistry*, *7*(2), 203-208.

[27] Samal, A. C., Bhattacharya, P., Mallick, A., Ali, M. M., Pyne, J., & Santra, S. C. (2015). A study to investigate fluoride contamination and fluoride exposure dose assessment in lateritic zones of West Bengal, India. *Environmental Science and Pollution Research*, *22*(8), 6220-6229.

[28] Susheela, A. K. (2001). Fluorosis: Indian scienario: A treatise on fluorosis. *Fluorosis Research and Rural Development Foundation*. 34(3), 181-183.

[29] Wedepohl, K. H. (1974). Copper: Abundance in common sediments and sedimentary rocks. *Handbook of Geochemistry*, *29*, 1-10.

[30] Wuyi, W., Ribang, L., Jain an T, Kunli, L., Lisheng, Y., Haironge, L., & Yonghua, L. (2002). *Absorption and teaching of fluorides in soils of China Fluoride,* 35, 122-129.

[31] Yadav, J. P., & Lata, S. (2002). Assessment of fluoride toxicity and dental fluorosis in Sahlawas block of distt Jhajjar, Haryana. *Journal of Forensic Medicine and Toxicology*, *19*(1), 7-12.

[32] Yadav, J. P., Lata, S., Kataria, S. K., & Kumar, S. (2009). Fluoride distribution in groundwater and survey of dental fluorosis among school children in the villages of the Jhajjar District of Haryana, India. *Environmental Geochemistry and Health*, *31*(4), 431-438.

[33] World Health Organization (WHO). (2002). Environmental health criteria. Fluorides. Geneva. 227-251.